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ABSTRACT

A project was conducted at Wenatchee Valley College (Washington) to update the curriculum for the industrial refrigeration technician course. First, resource groups and information networks were contacted in order to obtain a wide range of available resources. In addition, contractors, manufacturers, and government agencies that serve the Pacific Northwest industrial refrigeration industry were informally interviewed to determine their needs. Although no specific information was located through the data banks, several contractors, manufacturers, and government agencies responded with a wide variety of appropriate engineering and field service manuals specific to their products and fields of expertise. Trade associations recommended texts and other materials. After evaluation of these materials and suggestions, the project members revised the curriculum to meet the needs of the refrigeration industry in the Pacific Northwest and to incorporate the latest technical information. The project also forged new relationships between the college and the area refrigeration industry so that employers were more willing to employ program graduates, companies were willing to donate equipment, and the program's enrollment increased substantially. (The course outline developed during this project, as well as a list of texts and resources, are included in this report.) (KC)

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UPDATING OF THE CURRICULUM FOR INDUSTRIAL REFRIGERATION COURSE

FINAL REPORT

Project No. 84-ATA(166)NB

Curriculum Development Project
Conducted Under Public Law 94-482

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
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December 27, 1984

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RESEARCH COORDINATING UNIT
Washington State Commission for Vocational Education

CE041048

FINAL REPORT

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UPDATING OF THE CURRICULUM FOR INDUSTRIAL REFRIGERATION COURSE

CURRICULUM DEVELOPMENT PROJECT
CONDUCTED UNDER
PUBLIC LAW 94-482

The project reported herein was performed pursuant to a grant from the Research Coordinating Unit of the Washington State Commission For Vocational Education. Contractors undertaking such projects under the Commission For Vocational Education sponsorship are encouraged to express freely their professional judgement in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Commission For Vocational Education position or policy.

Robert H. Eley
Wenatchee Valley College
December 27, 1984

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SUMMARY OF THE REPORT

Period covered by this report. From January 10, 1984 to September 29, 1984.

Objective

Update the curriculum for the industrial refrigeration technician course offered beginning September, 1984.

Sub-objectives

1. Upgrade the present refrigeration program for industrial and commercial application.
2. Develop a concise curriculum for each course offered.
3. Define skills needed to be learned and describe laboratory projects and demonstrations that will develop proficiency of those skills.
4. Secure support and recognition of course offering within the community and state.
5. Increase the number of students served by the program by better meeting their needs.

Procedures followed:

Initially, several resource groups were contacted in an attempt to obtain a wide range of available resources. Three resource data banks were accessible through the national network for curriculum coordination in vocational-technical education (N.N.C.C.T.V.E.). The three data banks consisted of:

1. Educational Resources Information Center (E.R.I.C.)
2. Vocational Education Curriculum Materials (V.E.C.M.)
3. Resources in Vocational Education (R.I.V.E.)

Contractors, manufacturers and government agencies that service the Pacific Northwest industrial refrigeration industry were informally interviewed and common concerns addressed during the curriculum revision. During the interview process, repeated references were made to a number of trade organizations. These organizations were contacted requesting educational information and/or field manuals. Both Seattle Community College and Spokane Community College were contacted and copies received of the current curriculum for their respective refrigeration programs. Lists of these contractors, manufacturers, trade organizations and government agencies are given in the appendix.

Results

There was no specific listing for information on industrial refrigeration available through the N.N.C.C.V.T.E. data bank. However, several contractors, manufacturers and government agencies responded with a wide variety of appropriate engineering and field service manuals specific to their products and fields of expertise. The trade organizations that responded made available lists of periodicals and texts which they publish. Several periodicals were available by request while others were reviewed and purchased as resource materials for this study and incorporated into the revised curriculum. Area contractors and fruit warehouse managers identified additional applications of industrial refrigeration necessary to students' post graduate success.

Evaluation

The evaluation process was completed by:

1. Comparison of the proposed revised refrigeration curriculum with curriculum currently used in other community colleges and trade schools.

2. Comparison of the current industrial refrigeration curriculum with the demands and requirements of the industrial refrigeration community.

3. Comparison of the current industrial refrigeratin curriculum with the proposed revised curriculum by the refrigeration advisory committee.

Conclusions and Recommendations

The two target populations affected by this project were the students entering the refrigeration technology program with minimal knowledge and skills in refrigeration, and the industrial refrigeration community in the Pacific Northwest, including Alaska.

Refrigeration technology programs cannot adequately prepare students for post graduate employment with course content including domestic and light commercial applications, specifically ammonia systems (with strong emphasis on safety precautions and handling procedures), and controlled atmosphere (CA) condition monitoring and equipment maintenance. Students are more fully prepared to function knowledgeably as the industrial refrigeration community requires, with both training equipment capable of assimilating industrial refrigeration applications, and field experience providing supervised, on-the-job training with follow-up evaluations.

When involved in the revision, evaluation and implementation of the Wenatchee Valley College refrigeration program, greater acceptance of the program by the industry was evidenced by donations of necessary training equipment, definition of requirements and expectations of refrigeration technicians, provision of field experience with follow-up evaluations, and student referrals to the program. Student enrollment in the program has increased greater than 50% specifically due to greater involvement of refrigeration employers with the course, resulting in a more comprehensive teaching program. The students have also been attracted by the implementation of an Associate of Applied Science Degree and a one year Certificate program.

Several recommendations can be made for continued growth of the refrigeration technology program based upon the evaluation procedures applied. Specifically, electronic, solid state and computer control systems as well as new CA monitoring equipment need to be incorporated into the curriculum as soon as it becomes economically feasible. A good relationship between the industrial refrigeration community and Wenatchee Valley College must be maintained to keep pace with this rapidly changing industry, thus maintaining awareness of new developments and changes in applications for refrigeration.

BODY OF THE REPORT

Refrigeration has had an increasingly significant impact upon the modern western lifestyle. The majority of consumer products, from automobiles to foods, are at some time dependent upon a refrigeration process. Since World War II there has been a rapid increase in new products, combined with marked improvements in the manufacturing processes of older products. Without refrigeration, aluminum and tires could not be manufactured and the data processing industry could not be used. (Marsh and Olivio, 1979)

In a large part, the health and quality of life that is enjoyed can be contributed to the vast quantity and variety of modern pharmaceuticals that are available as an aid in combating diseases common to humanity. Many of the pharmaceuticals, for example penicillin and its derivatives, as well as many vitamins used today, would not be available without a refrigeration process at some time in either the manufacture or storage of the product. (Chege, 1979)

Commercial preservation of food remains one of the most important applications of refrigeration. Large scale commercial preservation and transportation of food is so vitally important to the western lifestyle that it is not feasible to envision the world without refrigeration. (Chege, 1979) At some time, the majority of America's food supply has been stored under refrigerated conditions so that it can be processed or sold at a later date. This is done to maintain an adequate food supply to meet a year round demand and maintain more favorable prices for the producer of the product. Therefore, fresh produce that is purchased out of its normal growing season or grown in a region other than where it is purchased, would not be possible without refrigeration.

As society has become more urbanized, the logistics of supplying cities and communities have had to become more centralized. Thus, many of the major chain food stores have also centralized their warehousing and distribution processes. Of these facilities in the Pacific Northwest and Alaskan regions, greater than 50% are maintained by ammonia refrigeration systems requiring skilled operators and mechanics for maintenance and repair. The trend toward more automated plants and increasingly shophisticated machinery requires that operating technicians have a broader, more comprehensive knowledge of refrigeration than previously required. The best designed and well-constructed refrigeration plant cannot run efficiently if plant personnel do not have adequate knowledge and skills. Comprehensive

knowledge of plant equipment and refrigeration theory is essential. (Hallowell, King and Stepnich, 1972) Much of the equipment maintaining these warehouses is very old and many times outdated. However, many of these systems are newer high speed screw or rotory type compressors with up to date computer controls to regulate and protect millions of dollars worth of products. Refrigerants used in these systems range from several different types of halocarbons to ammonia, a Class II refrigerant with its own specific handling requirements, problems and benefits. This is the multi-faceted industry with which commercial-industrial refrigeration graduates are faced.

It is because of the need for knowledgeable, well-trained refrigeration technicans, that Wenatchee Valley College, a community college in North Central Washington, whose graduates primarily become employed in the Pacific Northwest and Alaskan areas, felt it necessary to re-evaluate the industrial refrigeration curriculum and offer a course responsive to the requirements and expectations of the industrial refrigeration industry. It was imperative that those expectations and requirements be clearly and specifically defined to facilitate the evaluation and revision of the refrigeration curriculum, students' job skill levels and graduate students employable in his or her chosen field. It was with these purposes in mind that the following objectives for this research were established.

Objective.

Update the curriculum for the industrial refrigeration technician course offered beginning September, 1984.

Sub-objectives.

1. Upgrade the present refrigeration program for industrial and commercial application.

2. Develop a concise curriculum for each course offered.

3. Define skills needed to be learned and describe laboratory projects and demonstrations that will develop proficiency of those skills.

4. Secure support and recognition of course offering within the community and state.

5. Increase the number of students served by the program by better meeting their needs.

To determine what research had previously been done in industrial refrigeration, a literature search was conducted. This research was very extensive in that it consisted of a number of resource data banks such as.

1. The Educational Resources Information Center (E.R.I.C.)
2. Vocational Education Curriculum Materials (V.E.C.M.)
3. Resources in Vocational Education (R.I.V.E.)

Existing curricula used at two other community colleges and one private technical training school within the same service district were reviewed and recommendations gleaned. Trade organizations serving the refrigeration industry were sent requests for educational resource materials and/or field manuals.

The data bank search yielded nothing of value. However, the trade organizations responded with a wealth of pertinent information, much of which was incorporated into the curriculum revision. Further, it was found that although the other schools cover domestic and light commercial refrigeration in some depth, most lightly cover industrial refrigeration or just do not address the subject.

The primary industries in the geographical service district of Wenatchee Valley College are farming (ground, tree, vind crops), fishing and science related (aluminum, aircraft, hi-tech), manufacturing industries that require refrigeration of their product during the manufacturing or processing. Many of the food products grown in these areas are stored for long periods and cannot be stored at normal temperatures or atmospheric conditions without spoilage occurring.

In Central and North Central Washington, the major food related industry is fruit production of varying types, each requiring similar temperatures but differing atmospheric conditions to prevent dehydration during long term storage. (Kupferman and Waelti, 1983) Long term storage consists of placing fruit in storage conditions for an average of eight to eleven months. (Olsen, 1983) To prevent the fruit from maturing too rapidly, the room is maintained under a strictly controlled atmosphere (CA) condition with a low oxygen level of 1.5 - 2.0%, compared to a normal room air oxygen level of 20 - 21%. (Olsen, 1983) Refrigeration requirements for these facilities are massive since large quantities of fruit, literally tons per storage room, must be cooled from ambient air temperatures to holding temperatures of 31 - 32 degrees fahrenheit in five to ten days. (Yost, 1983) This creates an unusual condition in that once the fruit is cooled to holding temperatures, the refrigeration capacity required for maintaining that temperature is just a small fraction of the pull down requirements. (Bartsch and Blanpied) This radical change in capacity creates a whole new list of problems for refrigerant flow, oil return to the compressor and compressor wear difficulties.

In order to establish the refrigeration training and theory needs within the local community, a number of searches were conducted. First the propsective employers were interviewed. These interviews supported the original premise that knowledge of ammonia refrigeration is essential to the students' success. The employers consistently expected refrigeration technicians to have a working knowledge of:

1. Ammonia safety precautions,
2. Ammonia's reaction as a refrigerant,
3. The basic types of equipment and controls with which technicians would be working.

The information gained during the interviews indicated a number of critial aspects of ammonia systems needing to be addressed in the curriculum revision.

1. Refrigerant handling safety
2. Leak detection procedures
3. Compressors
4. Flooded systems
   a) Metering devices
   b) Refrigerant flow control devices
5. Condensing systems
6. Compressors
7. Oil return
8. Refrigeration piping

The area most emphasized by employers was ammonia safety. Since ammonia is a Class II refrigerant, it is both toxic and some what flammable, as well as extremely caustic. Technicians must be familiar with ammonia operating procedures and safety precautions to prevent becoming a danger to himself or herself and others. This aspect is so highly critical and cannot be over emphasized in view of the disasters occurring at ammonia facilities within the past two years affecting densely populated areas in the United States.

The Refrigeration Advsiory Committee recommended that the feasibility of installing an ammonia system in the refrigeration laboratory be determined. The recommendation was accepted by the college administration and donations for an ammonia system were solicited with good results. Presently not all components have been located or acquired. However, the advisory committee and a number of the local contractors are involved in the project. When completed, the ammonia system will enable comprehensive instruction of ammonia refrigeration with both theoretical and practical application available, thus more fully addressing the concerns of the local refrigeration community.

After assessing the laboratory equipment available for practical application of other types of refrigeration systems, the advisory committee recommended that improvements be made when and if economically possible. Again donations were solicited resulting in two walk-in refrigeration boxes with mechanical components for both a medium temperature (32 - 40 degrees fahrenheit) and low temperature (32 degrees fahrenheit and lower) unit. It was decided that these units would not only act as trainers for trouble shooting, but could be re-installed annually. Greater variety and complexity of training equipment within the laboratory setting has been a tremendous improvement.

The advisory committee and program instructor remained concerned that the refrigeration program was still lacking by not providing any opportunity for field experience. Local warehouses and contractors were recruited that would be willing to.

1. Allow a student to spend one week working with their employees.
2. Provide a verbal evaluation of the student's performance at the conclusion of that week.

This program was designed and implemented, spring term 1984, to give the students exposure to actual field problems and offer the industrial refrigeration community further opportunity to become involved with the college. The responses from both the students and community were positive. The students felt the week was an invaluable educational opportunity and all the companies involved requested participation in the program again.

One remaining area not yet addressed yet needing inclusion in the revised curriculum was unexpectedly found when interviewing local CA storage employers. Refrigeration technicians employed by the CA storage companies were not only responsible for maintenance and repair of the CA equipment, but also the monitoring of the CA conditions. The employers felt strongly that the students should be exposed to this aspect during their course work.

Educational information and/or field manuals pertaining to CA control equipment were requested from those CA control equipment manufacturers and suppliers listed in the appendix. A considerable amount of information regarding oxygen burners, nitrogen generators and carbon dioxide scrubbers was made available.

Information regarding fruit storage and CA condition requirements was requested from the Wenatchee office of the United States Department of Agriculture (U.S.D.A.) and Washington State University (W.S.U.) Agriculture Research Departments. (Bartsch and Blanpied) U.S.D.A. responded with a vast amount of information on CA requirements.

From the concept of CA storage in the 1800's, the availability of fresh fruit out of season has become dependent upon it. CA is an area being continually researched and reviewed as new information becomes available. Changing to lower oxygen concentration levels and lowering those oxygen levels more rapidly have brought about the current usage of rapid CA.

The logistics of teaching rapid CA are nearly impossible on anything but an academic, theoretical level without actual CA rooms available. With the cooperation of U.S.D.A. and local warehouses, arrangements were made making it possible for students to gain practical understanding of CA principles via demonstrations of pull down and monitoring procedures.

By soliciting and encouraging community involvement in the process of revising the refrigeration curriculum, it is felt that the course better reflects the needs of the refrigeration industry, thus satisfying one of the objectives of this research project. Also by meeting the stated requirements of the industry, newly graduated technicians have a greater opportunity of becoming employed and the refrigeraiton technology program becomes an attractive prospect to individuals surveying the technical-mechanical trade programs.

Recent changes in the degree status of the refrigeration technology program at Wenatchee Valley College have also made the program more desirable. Previously the college offered only a two year Associate of Applied Arts Degree. With the curriculum revision it became possible to offer both a one year Refrigeration Technology Certificate and a two year Associate of Applied Science Degree. It was felt that the change from Applied Arts to Applied Science better reflected the course content.

The introduction of the one year certificate program has proven to be very attractive to the student with limited funds and time who needs to return to the work force as quickly as possible. Enrollment in the refrigeration program has had an unprecedented increase of greater than 50%. Student evaluations of the revised curriculum have given the following reasons for this increase:

1. Revision of the curriculum resulting in a more comprehensive teaching program.
2. Greater involvement of the employers in the course implementation.

From the information gained from multiple pertinent sources, the review of the course outline and source materials by the advisory committee and other review groups as described in the evaluation procedures, it is felt that the objectives of this research have been achieved.

REFERENCES

Bartsch, James A. and G. DAvid Blanpied. Bulletin 448, 25. Agriculture Engineering Extention. Cornell University, New York.

Chege, James M., Ed. Refrigeration and Air-Conditioning, Englewood: Prentice-Hall. 1979.

Hallowell, Elliott R., Guy R. King and Ivan Stepnich. Industrial Refrigeration Crs. 1. Chicago: Refrigeration Engineers and Technicians Associaton, 1972.

Kupferman, Eugene and Henry Waelty, Ed. 1983. Post Harvest Pomology Newsletter, Vol. 1. Tree Fruit Research Center, Wenatchee, Washington.

Marsh, R. Warren and C. Thomas Olivo. Principles of Refrigeration. New York: Delmar, 1979.

Olsen, Kenneth L. 1983. "Suggestions for CA Storage from Investigations Still in Progress in Washington State" p. 10-13. Post Harvest Pomology Newsletter, Vol. 1. No. 1.

Waelti. Henry. 1983. "Controlled Atmosphere Storage Equipment", p. 19-23. Post Harvest Pomology Newsletter, Vol. 1, No. 3.

Yost, Gene. 1983. "Packed Unitized Apples Should Be Cooled Before Shipment", p. 14-15. Post Harvest Pomology Newsletter, Vol. 1. No. 1.

REFRIGERATION 111

COMMERCIAL AND INDUSTRIAL REFRIGERATION

Course Outline for Winter Quarter

I. COMPRESSORS

A. Reciprocating
   1) Hermetic
   2) Semi-hermetic
   3) Open
      a) Direct Drive
      b) Belt Drive

B. Rotory
   1) Hermetic
   2) Semi-hermetic
   3) Open
      a) Direct Drive
      b) Belt Drive

C. Screw
   1) Hermetic
   2) Semi-hermetic
   3) Open
      a) Direct Drive
      b) Belt Drive

Sources and Handouts
Modern Refrigeration, Chapter 4, p. 115-139
Chapter 12
Manufacturers' Manuals
Carrier 5-F, 6-H
Trane
Mycom
York

II. CAPACITY CONTROL

A. Unloaders
   1. Suction Pressure Initiated, Oil Pressure Operated.
   2. Electrically Initiated
      a) Oil Pressure Operated
      b) Discharge Pressure Operated

B. Compressor Cycling

C. Hot Gas By-pass

D. Vanes
   1. Variable Port
   2. Butterfly

Sources and Handouts
Manufacturers' Manuals
Carrier
Trane
Mycom

III. CONDENSERS

A. Air Cooled
   1. CFM Per Ton of Refrigeration
   2. Installation Clearances
   3. Installation Precautions for Remote Mounting

B. Evaperative

C. Water Cooled
   1. Tube in Tube
   2. Tube in Shell
   3. Coil in Shell
   4. Gallons Per Minute

D. Water Problems
   1. Algae
   2. Scale
   3. Acidic
   4. Dirt

E. Water Treatment
   1. PH Control
   2. Algicides
   3. Acid Flushing
   4. Filtration

Sources and Handouts
Modern Refrigeration, Chapter 12, p. 407-412

Manufacturer's Manuals
Trade Organizations
Air Force Hand-out

IV. METERING DEVICES

A Capillary Tubes

B. Expansion Valves
1. Automatic
2. Thermostatic
a) Internal Equalized (under 2# internal pressure drop)
b) External Equalized (over 2# internal pressure drop)
3. Float Valves
a) High Side
b) Low Side

Sources and Handouts
Modern Refrigeration, Chapter 12

Manufacturer's Manuals
Sporlan
Alco
Refrigeration Specialities

V. EVAPERATORS

A. Plate

B Bare Tube

C. Tube & Fin
1. Blow Through
2. Draw Through

D. Flooded
1. Secondary Refrigerant Flow Problems
2. Freeze Up Precautions

Sources and Handouts
Modern Refrigeration, Chapter 12

Trande Organizaton Handout

VI. DEFROST SYSTEMS

A. Electric

B. Hot gas

C. Cool Gas

D. Hot Water
   1. Condenser Heated
   2. Electrically Heated

E. Air Defrost
   1. Refrigerated Space
   2. Ambient Air

F. Defrost Initiation Methods
   1. Time
   2. Temperature
   3. Electronic Eye

G. Defrost Termination Methods
   1. Time
   2. Temperature

H. Evaperator Fan Delay
   1. Time
   2. Temperature

Sources and Handouts
Modern Refrigeration, Chapter 8, p. 243-275

Manufacturers' Manuals
Copeland Manual
Trade Organization Handout

VII. CONTROLS

A. Temperature Electric
   1. Cross Ambient Charged
   2. Liquid Charged
   3. Solid Charged

B. Pressure Electric
   1. Low Pressure Switch
   2. High Pressure Switch
   3. Oil Pressure Safety Switch

C. Solid State
   1. Single Station
   2. Multi-station

Sources and Handouts
Modern Refrigeration, Chapter 8, p. 243-275
Chapter 12, p. 433-443

Manufacturers' Manuals
Ranco
Penn-Baso
Honeywell

VIII. REFRIGERANTS

A. R-717, AMMONIA

B. R-12, Dichlorodifloromethane

C. R-22, Monochlorodifloromethane

D. R-500, Aziotropic

E. R-502, Aziotropic

Sources and Handouts
Modern Refrigeration, Chapter 9

Manufacturers' Manuals
Copeland
Dupont
Allied Chemical

IX. SECONDARY REFRIGERANTS

A. Types
1. Brine
2. Ethyl Glycol
3. Freon (Double Cold)

B. Purpose
1. Long Runs
2. Multiple locations

Sources and Handouts
Modern Refrigeration, Chapter 9

Manufacturers' Manuals
Copeland
Double-Cold
Carrier

X. SYSTEMS

A. Series
1. Low Termperature Application

B. Parallel
1. Medium Temperature Application

Sources and Handouts
Manufacturers' Manuals
Copeland
Carrier
Trade Organization Handouts

XI. APPLICATION

A. Bars
   1. Beer Cooling

B. Restaurants
   1. Short Term Food Storage
   2. Beverage Coolers
   3. Product Storage Problems

C. Stores and Markets
   1. Short Term Food Storage
   2. Various Product Storage

D. Food Processing and Storage
   1. Short Term Storage
   2. Long Term Storage
   3. Freezer Belts

E. Ice Machines
   1. Flaked
   2. Chipped
   3. Cube

Sources and Handouts

Modern Refrigeration, Chapter 12, p. 418-428

Manufacturers' Manuals

Copeland
Carrier
Frigidaire
Kold Draft
Scottsman

XII. SYSTEM LOADS

A. External
   1. Ambient Temperature Difference
   2. Solar
   3. Convection

B. Internal
   1. Lights
   2. Motors
   3. People
   4. Product

Sources and Handouts

Modern Refrigeration, Chapter 15

Manufacturers' Manuals

Copeland
Russel Coil

XIII. HEAT TRANSFER

A. R-Factor

B. C-Factor

C. U-Factor

D. Constructin Materials
   1. Walls
   2. Ceilings
   3. Floors
   4. Doors
   5. Insulation

E. Construction Methods
   1. Package
   2. On Sight Construction

Sources and Handouts
Modern Refrigeration, Chapter 15

Manufacturers' Manuals
Copeland
Russel Coil

XIV. PRODUCT LOAD

A. Type of Product
   1. Spacific heat
   2. Heat or Respiration

B. Storage Conditons
   1. Temperature
   2. Relative Humidity

Sources and Handouts
Manufacturers' Manuals
Copeland
Russel Coil

XV. SYSTEM DESIGN

A. Piping Design
   1. Copper
   2. Steel
   3. Refrigerant Selection
   4. Suction Line Slope (1 inch per 10 feet)
   5. Vertical Lift and Static Head
   6. Oil Return Requirements
   7. Fitting Pressure Drop
   8. Double Risers

B. Specialty Components
   1. Accumulators
   2. Compressor Pressure Regulators
   3. Evaperator Pressure Regulators
   4. Head Pressure Controls

C. Floating Head Systems
   1. Application
   2. Advantages
   3. Components Required

Sources and Handouts
   Manufacturers' Manuals
      Copeland
      General Electric
      Carrier

XVI. CONTROLLED ATMOSPHERE SYSTEMS

A. Atmosphere Generating Equipment
   1. Nitrogen Generators
      a) Ammonia Cracking Systems (OXYDRAIN)
      b) Pressure Swing Absorption System (PSA)
   2. Oxygen Burners
      a) Tectrols
      b) Gen-o-fresh
      c) Catalytic Oxygen Burner (COB)

B. Carbon Dioxide Scrubbers
   1. Charoscrub
      a) Recirculating
      b) Activated Carbon
      c) Catalytic Oxygen Burner (COB)
   2. Modecular Sieve Absorber
      a) Operated in Combination with the COB System
      b) Molecular Sieve (Synthetic Zeolite)
      c) Air Purge
   3 Lime Scrubbers
      a) Hydrated High Cacium Lime (Ca(OH)2)
      b) Recurculated

C. Gas Analysis
   1. Orstat
      a) Manual
      b) Inexpensive
      c) Accurate
   2. Electronic
      a) Automatic
      b) Expensive
      c) Required Calibration Frequently

Sources and Handouts
   U.S. Dept. Agriculture
   Cornell University
   W.S.U. Agriculture Newsletters
   Manufacturers Field Manuals

REFRIGERATION 111

COMMERCIAL & INDUSTRIAL REFRIGERATION

LAB TASKS

1. Completely disassemble and reassemble the following compressors:

   A. One Semihermetic Compressor.
   B. One Open Drive Compressor.

2. Correctly install a single belt driven compressor (with correct alignment and belt tension).

3. Correctly install a multi-belt driven compressor (with correct alignment and belt tension).

4. Correctly install and adjust a low pressure switch to control a refrigerated space temperature.

5. Properly install and adjust an oil pressure safety switch.

6. Correctly install and wire a commercial defrost timer on to a refrigerator with electric defrost using a defrost thermostat.

7. Correctly install a suction line filter drier.

8. Correctly demonstrate pumping down a commercial and industrial refrigeration system and change out a liquid line filter drier.

9. Correctly diagnose and repair or replace a faulty TXV.

10. Correctly adjust a TXV for 12 degrees superheat.

11. Properly install and adjust a pressure activated water regulating valve.

12. A. Properly compute the refrigeration load of a given commercial refrigeration box.
    B. Draw a proper layout of the system using current piping equipment and techniques.
    C. Give a complete material list and estimate cost of the project installation.

ATMOSPHERE GENERATING EQUIPMENT MANUFACTURERS

Controlled Atmosphere
6475 S. Second
P O. Box 1188
Okanogan, WA 98840

Holec Gas Generator Company
6500 AB Nigegen HOLLAND
P O. Box 68

Pacific Columbia Company, Inc.
P. O. Box 2921
Yakima, WA 98907

ENGINEERING COMPANIES

Cascade Refrigeration, Inc.
16 E Penny Road
Wenatchee, WA 98801

Crowder Refrigeration Company
6475 S. Second
Okanogan, WA 98840

Doubl-Kold
609A North 20th Avenue
Yakima, WA 98902

Seattle Refrigeration & Manufacturing Corporation, Inc.
1057 S. Director
Seattle, WA

W.E. Stone Company, Inc.
4220 22nd Avenue West
Seattle, WA

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Wenatchee, WA 98801

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1100 Western Avenue
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REFRIGERATION CONTROL MANUFACTURING COMPANIES

Alco Controls
P. O. Box 12700
St. Louis, MI 63141

Honeywell Controls
Minneapolis, MN 55408

Johnson Controls, Inc.
507 E. Michigan Street
P. O. Box 423
Milwaukee, WI 53201

Refrigeration Specialties
2445 S. 25th Avenue
Broadview, IL 60153

Sporlan Valve Company
7525 Sussex Avenue
St. Louis, MI 63143

INDUSTRIAL REFRIGERATION COMPRESSOR MANUFACTURERS

Carrier Air Conditioning Company
Syracuse, NY

Copeland Corporation
Sidney, OH 45365

Frick Compressor Company
Waynesboro, PA 17268

Mycom Compressor Company
2945 Columbia Street
Torrance, CA 90503

Trane Company
La Crosse, WI 54601

York Corporation
Borg-Warner Central Environmental
Systems Division
P. O. Box 1592
York, PA 17405

TRADE ORGANIZATIONS

Air-Conditioning Contractors of America
1228 17th, N.W.
Washington D.C. 20036

Air-Conditioning & Refrigeration Institute
1815 N. Fort Meyer Drive
Arlington, VA 22209

American Society of Heating, Refrigeration & Air-Conditioning Engineers, Inc. (A.S.H.R.E.A.)
1791 Tullie Circle N.E.
Atlanta, GA 30329

Refrigerating Engineers & Technicians Association (R.E.T.A.)
230 N. Michigan Avenue
Chicago, IL 60601

Refrigeration Service Engineers Society (R.S.E.S.)
1666 Rand Road
Des Plaines IL 60016

The International Institute of Ammonia Refrigeration (I.I.A.R.)
111 East Wacker Drive
Chicago, IL 60601

Signature of Project Director

12-27-84
Date